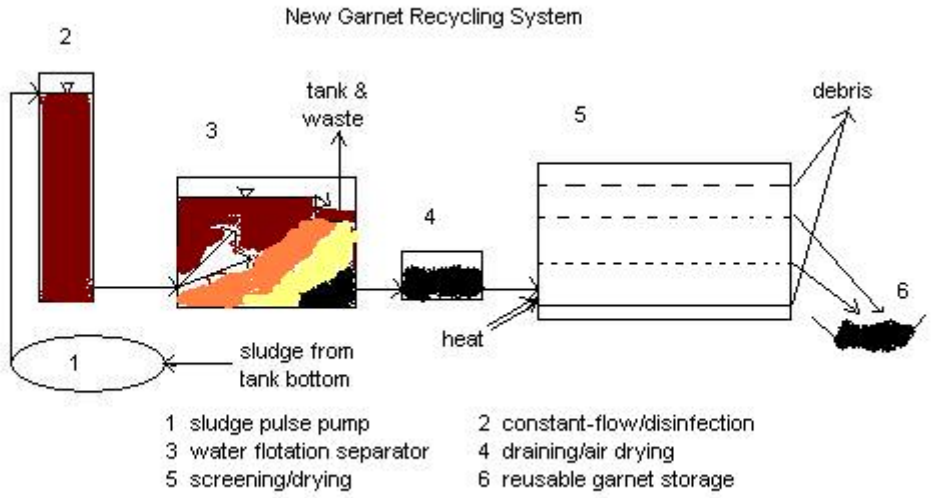
Development and Implementation of a Garnet Abrasive Recycling System

By Walter M. Kocher, Ph.D. and Amarin Kongtawelert

The NASA Glenn Research Center (GRC) and Cleveland State University (CSU) have partnered to develop, design and implement a system to recycle garnet abrasive material used in water knife operations.

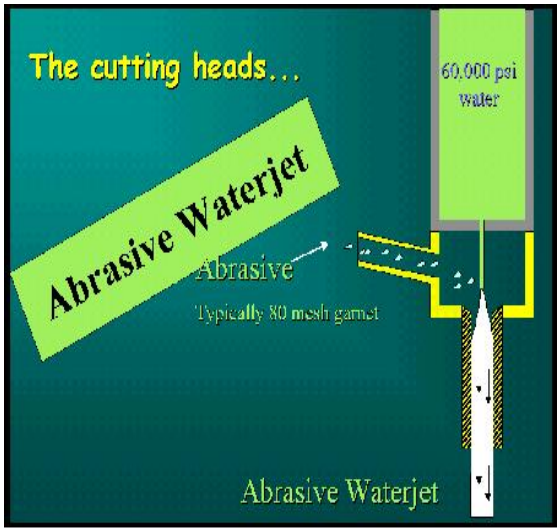
A water knife or waterjet cutting machine uses garnet abrasive material – similar to a fine sand – within the water jet to provide the capacity to cut metals and other materials that can not be cut using the water jet alone. The abrasive makes it possible to take advantage of the sophisticated water knife features when cutting a wide range of materials – including 9-inch thick steel. The high cost of the garnet abrasive, as well as disposal costs of the used materials, makes it cost-effective to recycle and reuse the garnet abrasive material in the water knife operations.



The only commercial options available to accomplish garnet recycling had high excess capacity, operated only on a continuous basis, elevated both water and energy usage, and had a high capital cost. The new system was developed to provide operational flexibility to the water knife operators, and was designed and implemented to function as a sustainable technology.

Laboratory studies were conducted at CSU to determine the most feasible unit operations that would maximize the recovery of reusable garnet, minimize waste generation, conserve both water and energy, and meet all of the performance criteria for the abrasive material use within the waterjet machine. Unit processes investigated included sedimentation, magnetic separation (to recover ferrous contaminants), screening (to meet size specifications and remove large debris), and water flotation (a process developed by CSU to utilize the kinetic energy in flowing water to separate the more-dense abrasive material from the lighter debris and contamination). Details of the laboratory

experiments and results are available through a presentation entitled “Development of a Garnet Abrasive Recycling System”. A much more thorough treatise of the research is available from the published Masters’ Thesis of Amarin Kongtawelert, Cleveland State University.



These results were used to initiate the “design and build” project phase – a close partnership with CSU and the Fabrication Shop at NASA GRC. The prototype system included a pumping unit (collecting water and abrasive “sludge” from the bottom of the water knife tank), water flotation unit (to separate most of the debris and light contaminants from the garnet), and a combined screening/drying unit (producing dry and usable garnet abrasive, and collecting small amounts of heavy contaminants and overused garnet - the garnet has a limited number of times that it can be reused effectively).

The requested features of the recycling system went through revisions while this phase was in progress. The major changes were for the provision of a water disinfection system to address health and safety issues, and to minimize inter-dependency of the system units to give more flexibility to water knife operators.

A chlorination disinfection system was incorporated into the front-end of the water flotation unit by modifying the “constant-head” container that was receiving the pulse-flow of sludge from the bottom pump (part of the standard waterjet machine). This provided disinfection for the water sitting stagnant in the tank, without violating GRC health and safety rules prohibiting the occasional dropping of a chlorine tablet into the tank.

Limited and inconsistent use of the water knife made a continuous-operation of the recycling system a disadvantage. Thus, the recycling system was revised to allow for batch operation and some intervention by the waterjet operators. This modification also promoted water conservation and energy conservation. The non-continuous operation allowed for draining/air drying of the initially separated material (produced by the water flotation unit), significantly reducing heating energy and screen-clogging problems of the screening/drying unit.

The completed unit also incorporated several layers of screens, producing more than one size/grade of reusable garnet product. This unique production of finer-grade garnet provides the preferred abrasive material for cutting certain materials, including glass.

The sustainable technology features of this new garnet abrasive recycling system go beyond the beneficial reuse of the garnet abrasive and minimizing waste generation and disposal. The system has also incorporated water and energy conservation features while addressing the problematic health and safety issues of stagnant water and the splashing of said water during normal waterjet operations. Providing a secondary garnet abrasive material, with specific applications, is an additional bonus.

A videotape (about 20 minutes) of the working system demonstration was presented at Ames Research Center during the NASA Affirmative Procurement and Pollution Prevention workshop in May of 2005. This tape, as well as the above mentioned documents, are available to all NASA Centers. The participants in this project would be happy to discuss any aspect of this system with any interested NASA personnel.